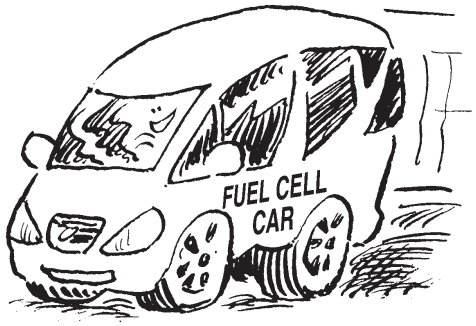
Fuel Cells



EPA's State and Local Climate Change Program helps build awareness, expertise, and capacity to address the risk of climate change at the state and local levels. The program provides guidance and technical information to help state and local agencies prepare inventories of greenhouse gas emissions, develop action plans to reduce emissions, and educate their constituents. By emphasizing the many economic and environmental benefits of greenhouse gas reductions, the program encourages state and local decisionmakers to implement voluntary measures to reduce their greenhouse gas emissions.

Energy from Fuel Cells

Fuel cells are a promising new energy technology under development today. A fuel cell is a device that chemically combines hydrogen and oxygen to provide electrical energy without combustion. Fuel cells produce electricity much like batteries do, but fuel cells require a steady supply of a hydrogen-rich fuel such as natural gas.

Fuel cells can be used to produce electricity, heat, and hot water with high efficiency, exceptionally low emissions, and low noise. When used to generate combined heat and power, or when running on hydrogen produced without the use of fossil fuels, fuel cells can reduce carbon dioxide (CO_2) emissions by 40 to 100 percent compared with conventional power plants or engines. They produce negligible air pollution, and operate so quietly that they can be used in vehicles or in residential neighborhoods to produce heat and hot water.

Fuel cells can power buildings, industrial and municipal facilities, cars, trucks, trains, and other equipment. They can operate with a variety of fuel sources, including natural gas, methanol, ethanol, landfill methane, coal gas, biogas, propane, gasoline, and pure hydrogen. When fuel cells are operated with hydrocarbon fuels, hydrogen is extracted by a reforming process that results in some CO_2 emissions. When using pure hydrogen produced through electrolysis by renewable or nuclear energy technologies, fuel cells generate no direct CO_2 emissions.

Five main types of fuel cells are under development today. The four in use or planned for power plant and building applications are: phosphoric acid fuel cells (PAFCs), molten carbonate fuel cells (MCFCs), proton-exchange membrane (PEM) fuel cells, and solid oxide fuel cells (SOFCs). A fifth type, the direct methanol fuel cell, is being developed and tested for transportation applications, along with PEM fuel cells, PAFCs, and SOFCs.

PAFCs are the most mature fuel cell technology and are commercially available. MCFCs and SOFCs are considered the next generation of fuel cells, with higher efficiencies and lower capital costs. All of the major automobile manufacturers are developing PEM or other fuel cell-powered vehicles, although no models are commercially available. Ongoing research with new materials and approaches is expected to yield additional new fuel cell types or applications in the near future.

The main barrier to the widespread use of fuel cells is their cost. The installed cost of commercially available stationary fuel cell power plants exceeds $2,000 per kilowatt, compared with

BENEFITS OF FUEL CELLS

- More efficient than combustion technologies.
- Reduce air pollution and greenhouse gases.
- Decrease dependence on imported oil.
- Produce jobs.
- Modular construction, easily scaled up or down in size.
- Distributed power generation reduces transmission losses.
- Can be used for cogeneration of heat and power.
- Can use a variety of fuels.

$400-$800 per kilowatt for a natural gas combined-cycle power plant. In order for fuel cells to become economical in vehicles, their cost would have to drop to less than $100 per kilowatt.

Costs are indeed falling as new fuel cell technologies are developed and as commercialization brings about economies of scale. The U.S. Department of Energy projects that fuel cells will provide electricity to buildings at only 6 cents per kilowatt-hour by the year 2005, dropping to 5 cents in 2010. At this price, fuel cells would be competitive with conventional energy generating sources in several markets.

The Federal Role

The Federal Energy Technology Center of the U.S. Department of Energy (DOE) is the largest single funder of research and development for stationary power-generating applications. The center's goal is to develop cost-effective, efficient, and environmentally attractive fuel cell systems that operate using fossil fuels.

In addition, DOE's Office of Transportation Technologies works with industrial and academic partners to develop automotive fuel cell propulsion systems. The public-private Partnership for a New Generation of Vehicles also serves as a focal point for developing automotive fuel cells.

The U.S. Department of Defense (DoD) has installed 30 stationary 200-kilowatt fuel cells since 1995 at bases around the country. Heat from the fuel cells is used for boilers, domestic hot water, space heating, and process hot water. As of January 1999, the 30 fuel cells had saved a combined total of $2,704,711 in energy costs and had abated 16,094 tons of CO_2, 280 tons of sulfur oxides (SO_X), 129 tons of nitrogen oxides (NO_X), and 11 tons of carbon monoxide (CO).

DoD also funds the Climate Change Fuel Cell Program, which provides grants to nonfederal agencies and organizations to install fuel cells. In some fiscal years, DoD provides funds to the U.S. Department of Energy to administer the Climate Change Fuel Cell Program.

State Experience with Fuel Cells

A number of states use fuel cells to power wastewater treatment plants, schools, and other facilities. Some states consider fuel cells as "renewable" sources of energy in state renewables portfolio standards, net metering, and other programs that encourage or require the use of renewable energy to generate electricity. California supports fuel cells through grants and air quality permit exemptions. Oregon provides low-interest, fixed-rate financing and business income tax credits of up to $700,000 for fuel cell projects.

New Jersey

The New Jersey Department of Transportation (NJDOT) has 66 solar-powered variable-message signs for use on state highways and roads. During cold winter nights, the signs' batteries often fail. The cost of retrieving, recharging, or replacing dead batteries runs to $10,000 per year, prompting NJDOT to install backup energy supplies. Instead of using diesel generators, the department decided to install fuel cells on about half of the signs. The fuel cells have performed flawlessly and may allow the department to earn greenhouse gas credits under the state's emissions credit program.

The installed fuel cells have a payback period of less than 3.5 years, so NJDOT plans to add fuel cells to the rest of its variable-message signs in 1999. If the department had used diesel-powered generators, each sign would have required approximately 25 gallons of diesel fuel twice per week. The fuel cells thus avoid the emissions associated with burning 171,600 gallons of diesel fuel per year.

New York

The Westchester County Wastewater Treatment Plant in Yonkers, New York, runs a fuel cell power plant using gas produced during anaerobic digestion of sewage. The fuel cell, operated by the New York Power Authority with funding from the U.S. Environmental Protection Agency and the U.S. Department of Defense's Climate Change Fuel Cell Program, began operation in May 1998 and has generated more than one million kilowatt-hours of electricity. A similar power plant began operating in Portland, Oregon, in May 1999 at the Columbia Boulevard Wastewater Treatment Plant.

The Westchester fuel cell emits approximately 60 percent less CO_2 than a conventional power plant and consumes 1,800 cubic feet of methane per hour. The methane, which makes up 60 percent of the gas produced by the anaerobic digester, would otherwise be burned off. Preliminary measurements by EPA indicate that emissions of carbon monoxide and volatile organic compounds from the system are too low to be detected. The fuel cell avoids 3,400 pounds per year of nitrogen oxides and 2,300 pounds per year of sulfur oxides from electricity production. It also avoids 4,100 pounds per year of carbon monoxide, 730 pounds per year of nitrogen oxides, and 620 pounds per year of sulfur oxides by not burning the digester gas.

For More Information

DOE's *Federal Energy Technology Center* has information on fuel cells and funding opportunities.
Website: *http://www.fetc.doe.gov/products/power/fc.html*

The U.S. Department of Defense's *Fuel Cells Demonstration Program* has extensive experience with stationary fuel cells.
Website: *http://www.dodfuelcell.com/*

The *Climate Change Fuel Cell Program* funds stationary fuel cell applications for nonfederal users.
Tel: 304-285-4747
Website: *http://www.fetc.doe.gov/publications/factsheets/fact_toc.html*

DOE's Office of Transportation Technologies implements the *Federal Fuel Cells in Transportation Program.*
Website: *http://www.ott.doe.gov/oaat/fuelcell.html*

The *U.S. Fuel Cell Council* is an industry association dedicated to fostering the commercialization of fuel cells in the United States.
Tel: 202-293-5500
Website: *http://www.usfcc.com/*

EPA's *State and Local Climate Change Program* helps states and communities reduce emissions of greenhouse gases in a cost-effective manner while they address other environmental problems.
Website: *http://www.epa.gov/globalwarming/ and click on "Public Decision Makers" under the "Visitors Center."*